Evolution of the Sources of the X-ray Background

Günther Hasinger, MPE Garching

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Collaborators:

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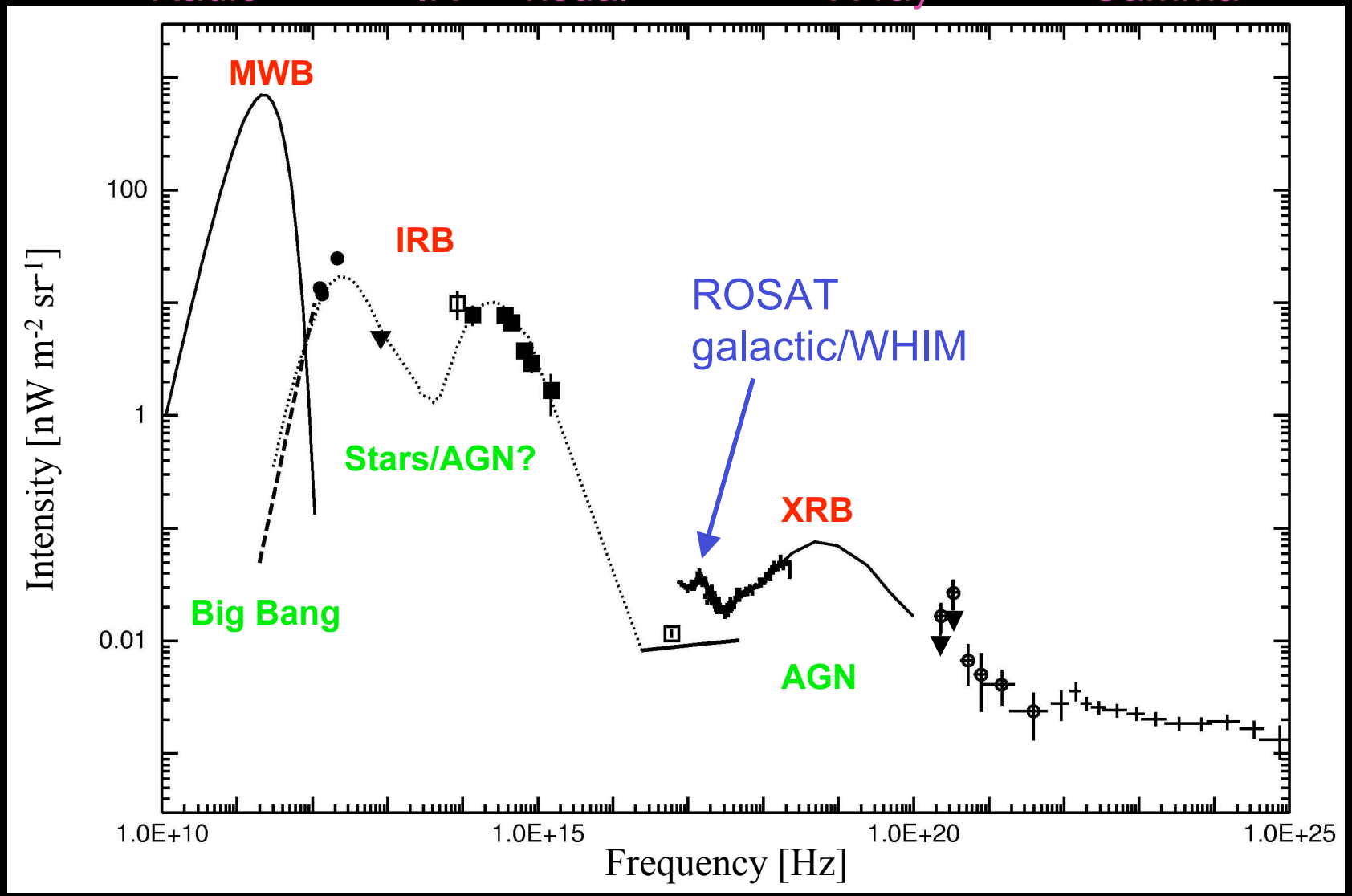
Lockman Hole: X. Barcons, H. Böhringer, A. Fabian, Y. Hashimoto, P. Henry, I. Lehmann, V. Mainieri, I. Matute, M. Schmidt, A. Streblyanskaya, G. Szokoly, M. Worsley

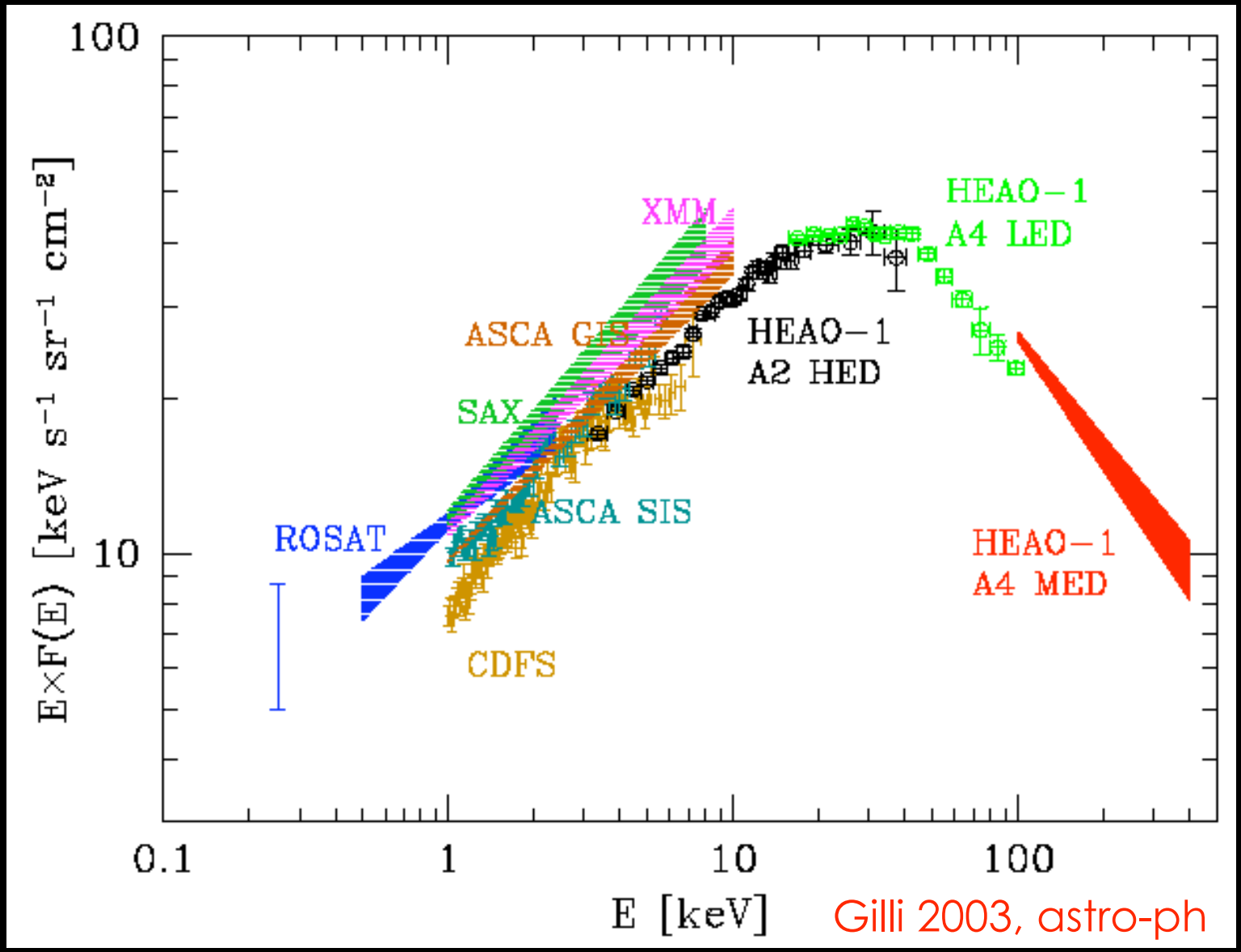
Overall Sample & Luminosity Function: T. Miyaji, M. Schmidt

Cosmic Energy Spectrum



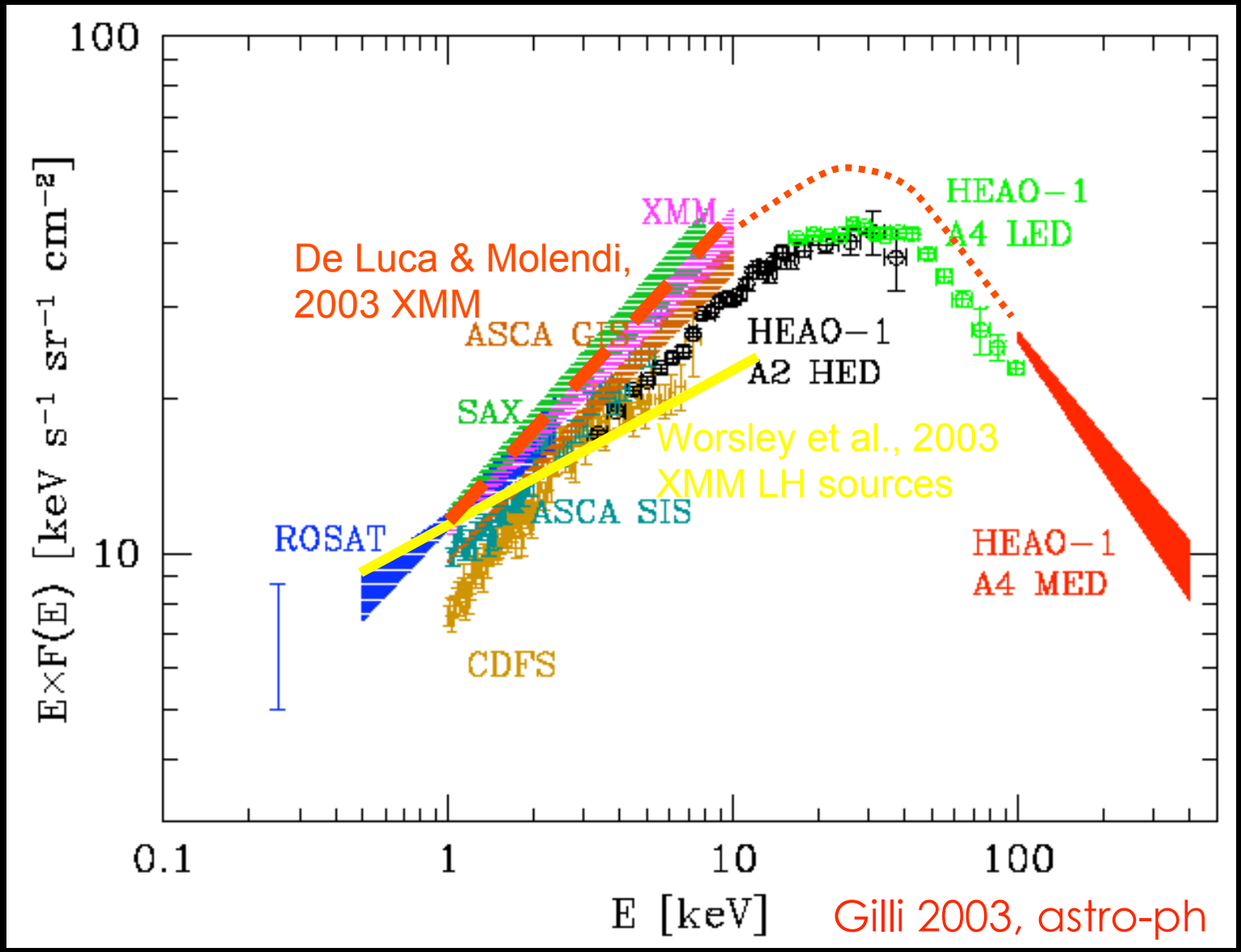
Hasinger 2000, astro-ph

The X-ray Background



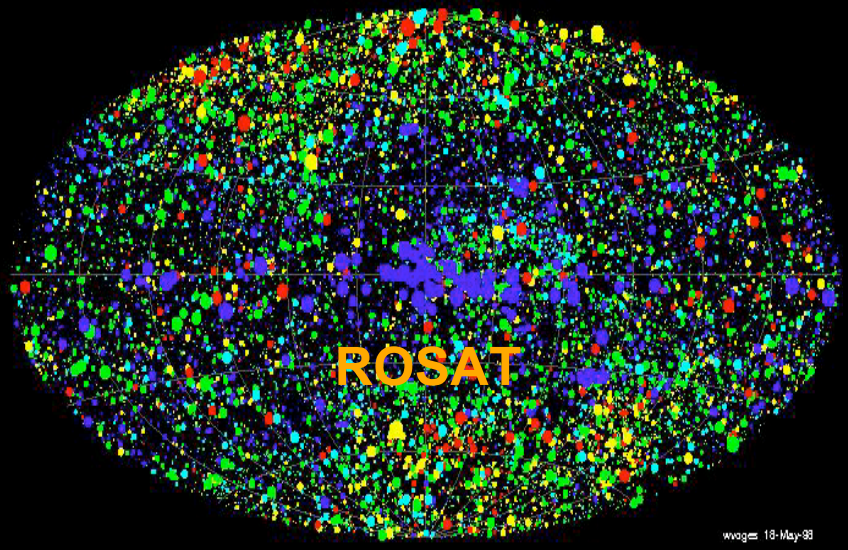
Gilli 2003, astro-ph

The X-ray Background

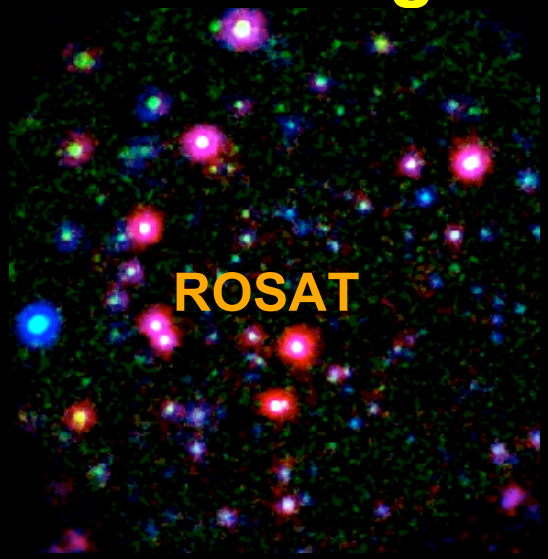


X-ray Surveys

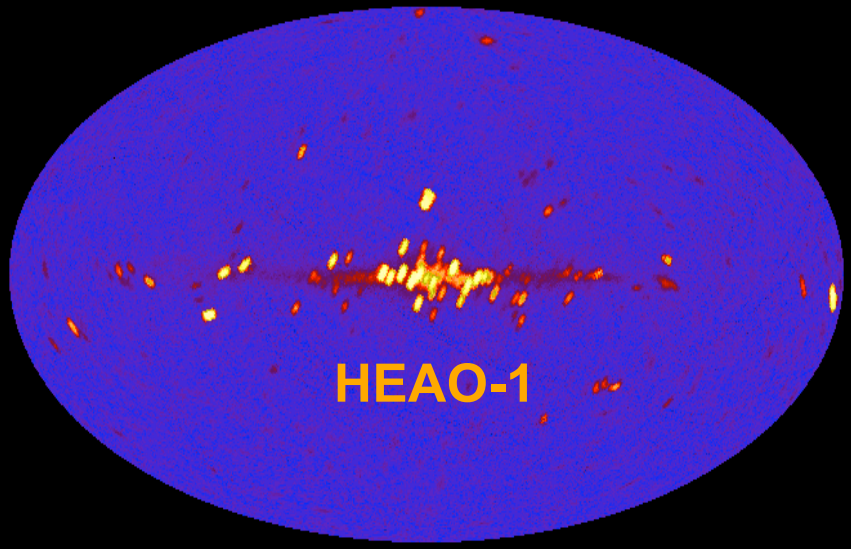
Scanning

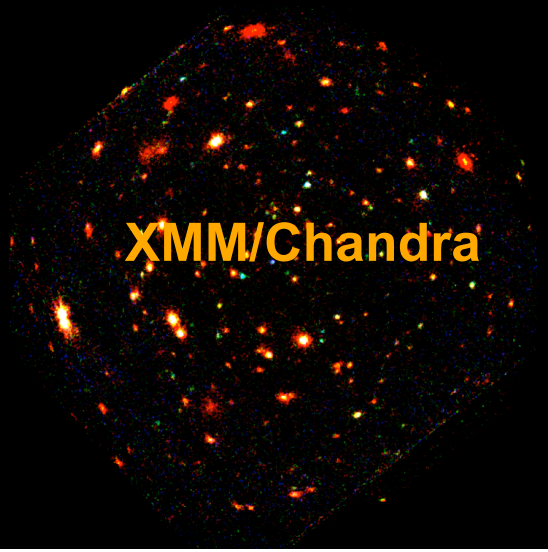


Pointing

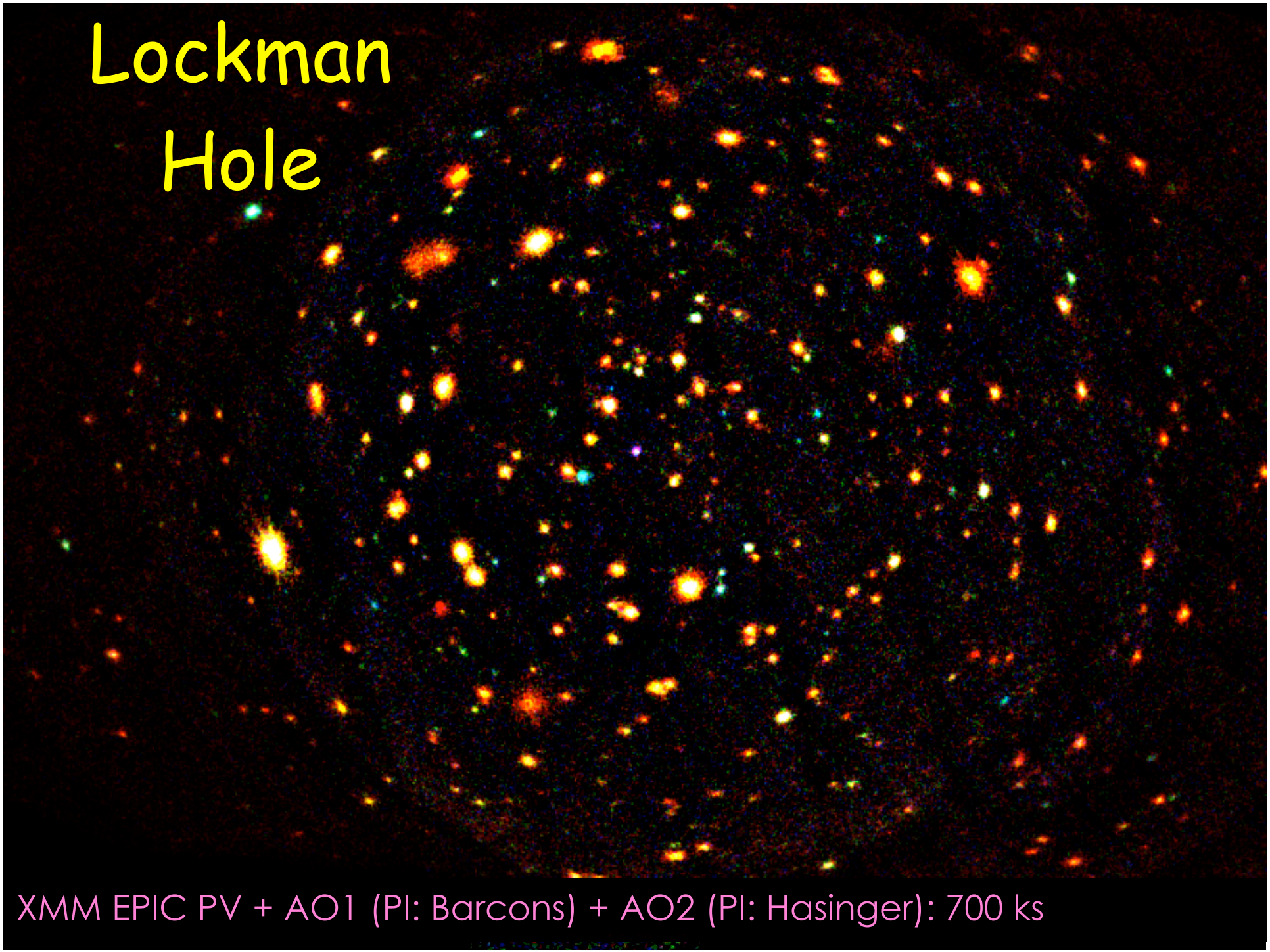


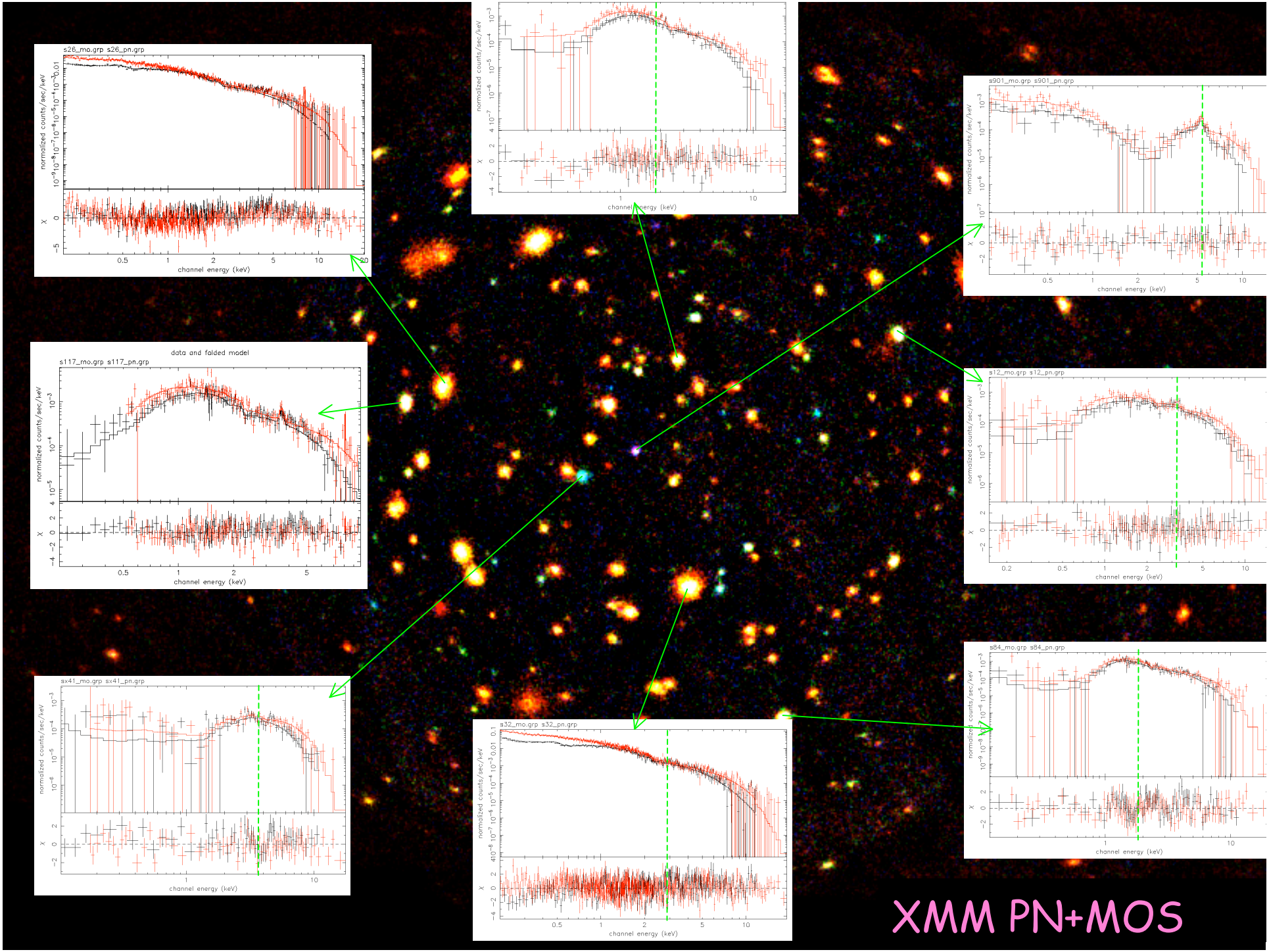
0.1-2 keV



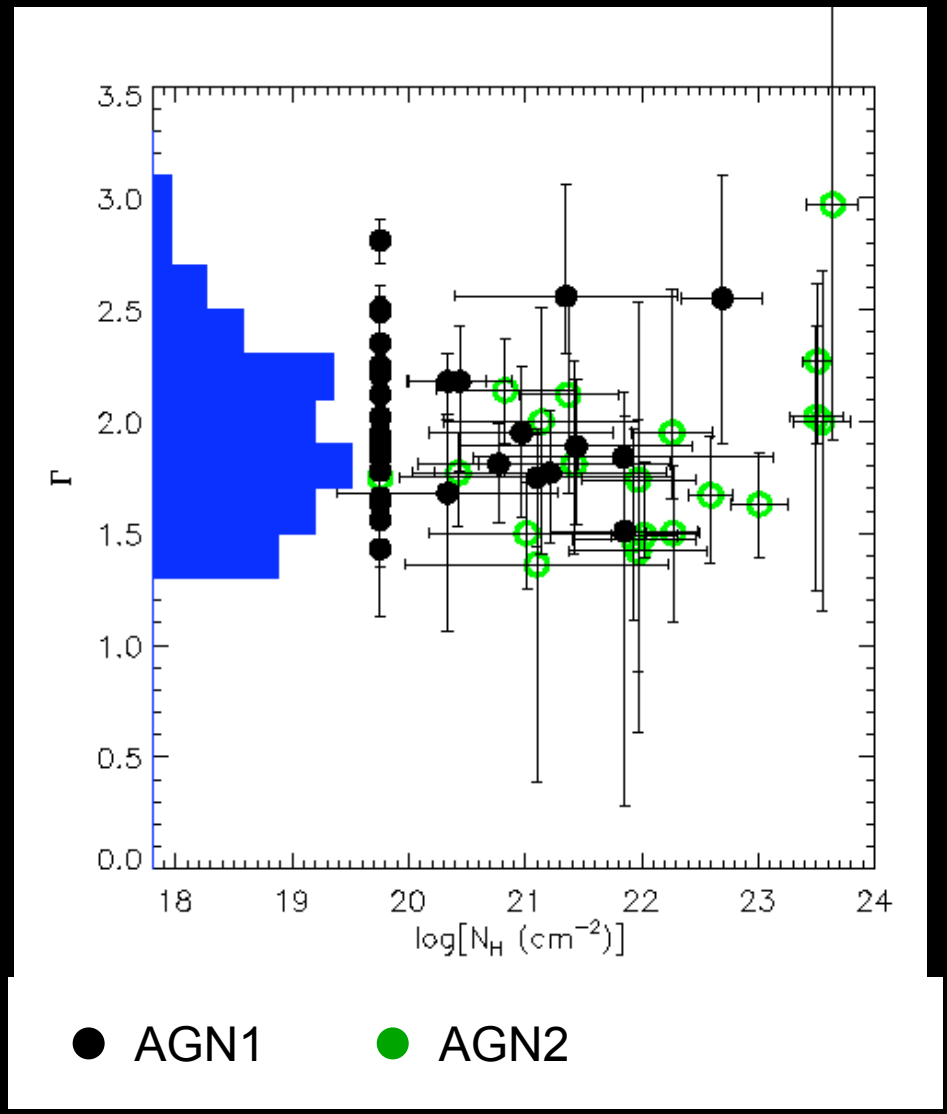


2-10 keV


Lockman
Hole
XMM EPIC PV + AO1 (PI: Barcons) + AO2 (PI: Hasinger): 700 ks

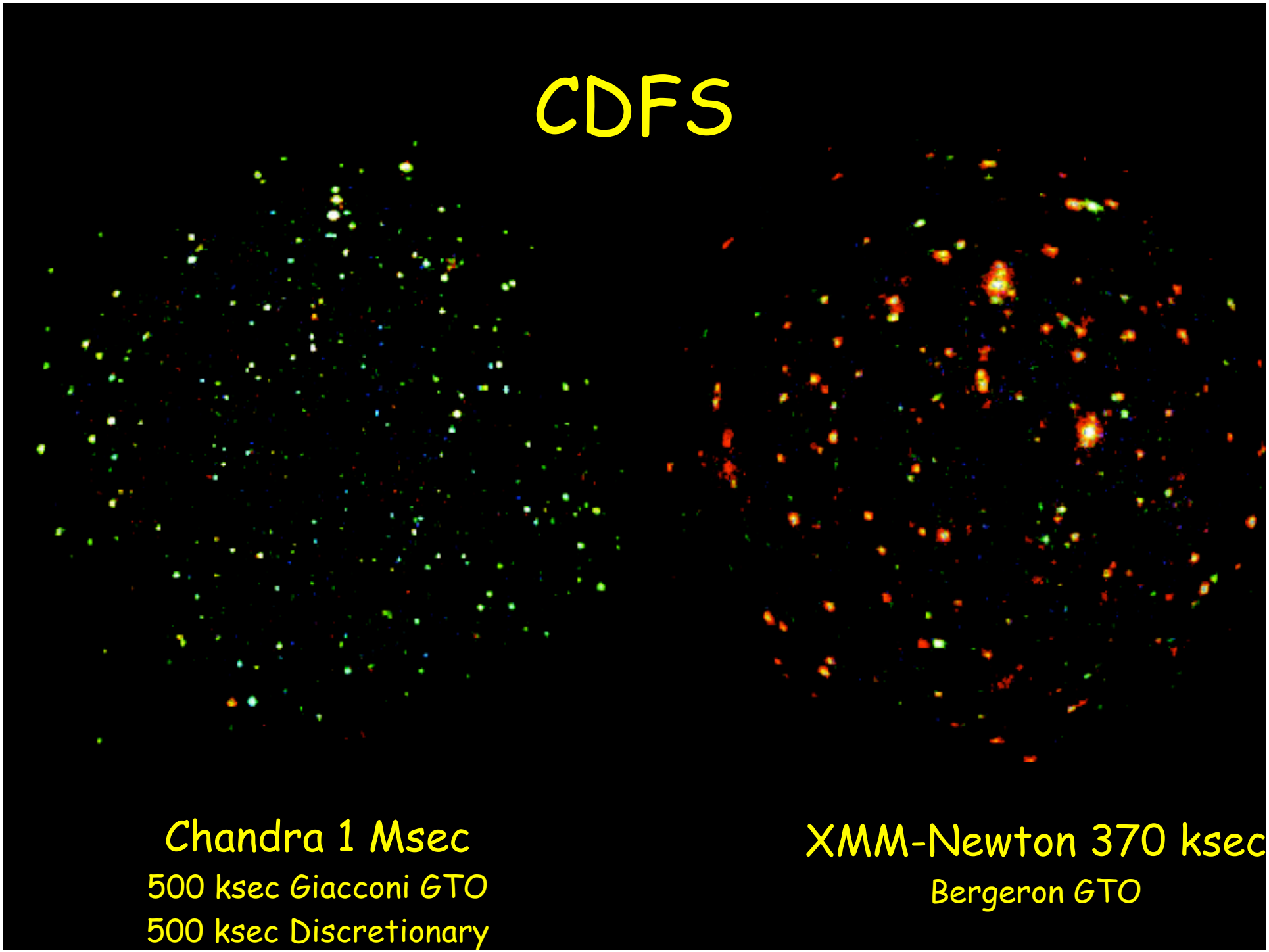

s26_mo.grp s26_pn.grp
normalized counts/sec/keV
channel energy (keV)
data and folded model
s117_mo.grp s117_pn.grp
normalized counts/sec/keV
channel energy (keV)
sx41_mo.grp sx41_pn.grp
normalized counts/sec/keV
channel energy (keV)
s32_mo.grp s32_pn.grp
normalized counts/sec/keV
channel energy (keV)
s901_mo.grp s901_pn.grp
normalized counts/sec/keV
channel energy (keV)
s12_mo.grp s12_pn.grp
normalized counts/sec/keV
channel energy (keV)
s84_mo.grp s84_pn.grp
normalized counts/sec/keV
channel energy (keV)
XMM PN+MOS

XMM LH Spectral Diagnostic



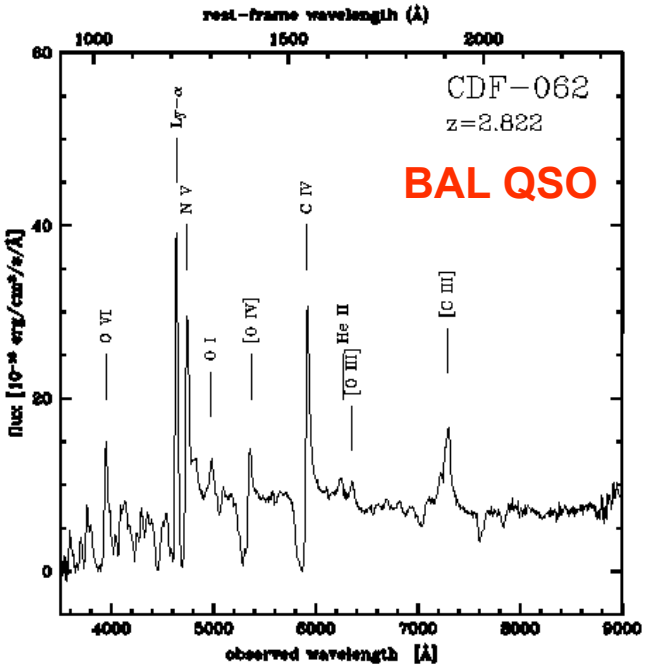
Confirming prediction of XRB synthesis models

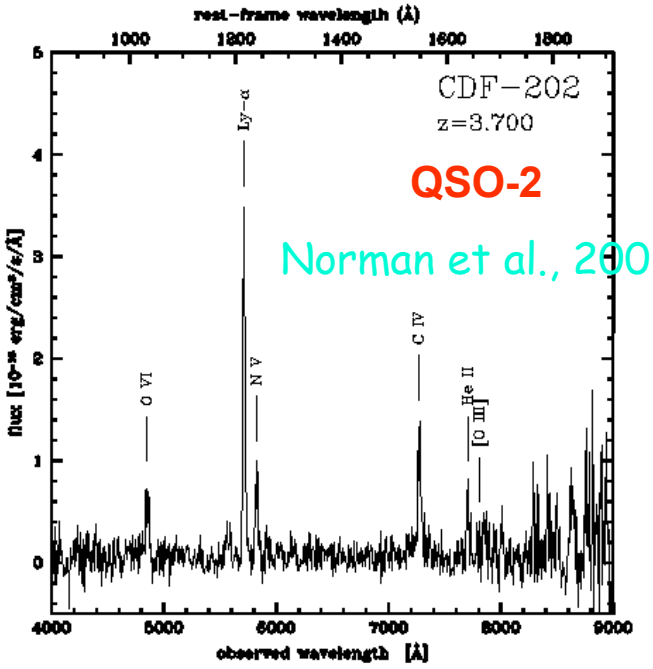
Mainieri , Bergeron et al. 2002


CDFS
Chandra 1 Msec
500 ksec Giacconi GTO
500 ksec Discretionary
XMM-Newton 370 ksec
Bergeron GTO

Optical Identifications

VLT FORS multiobject spectroscopy:
11 nights (2000-2001) 1-5 hrs exposures
Szokoly et al., 2003 (APJS)

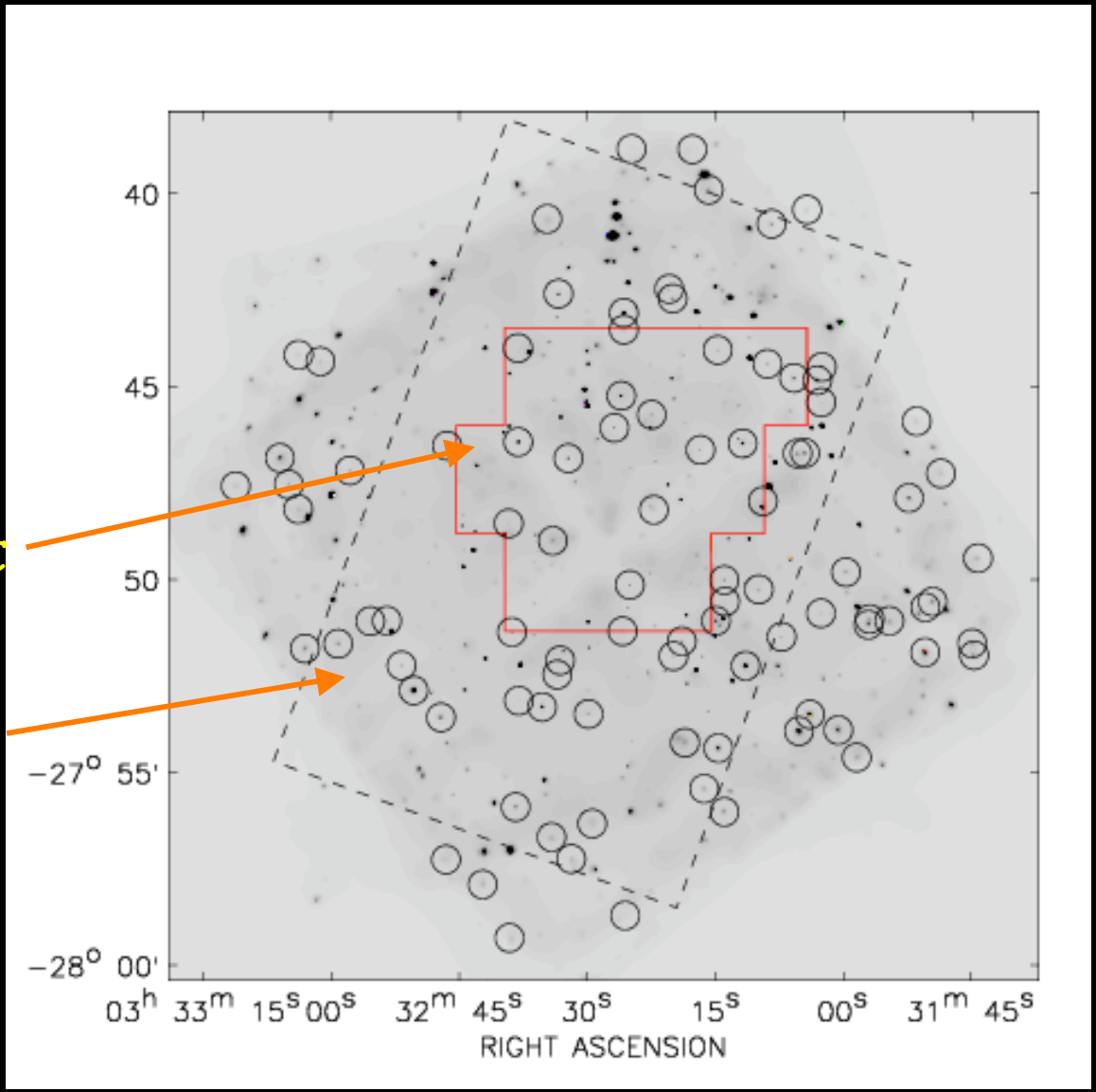




Norman et al., 2002

GOODS Survey

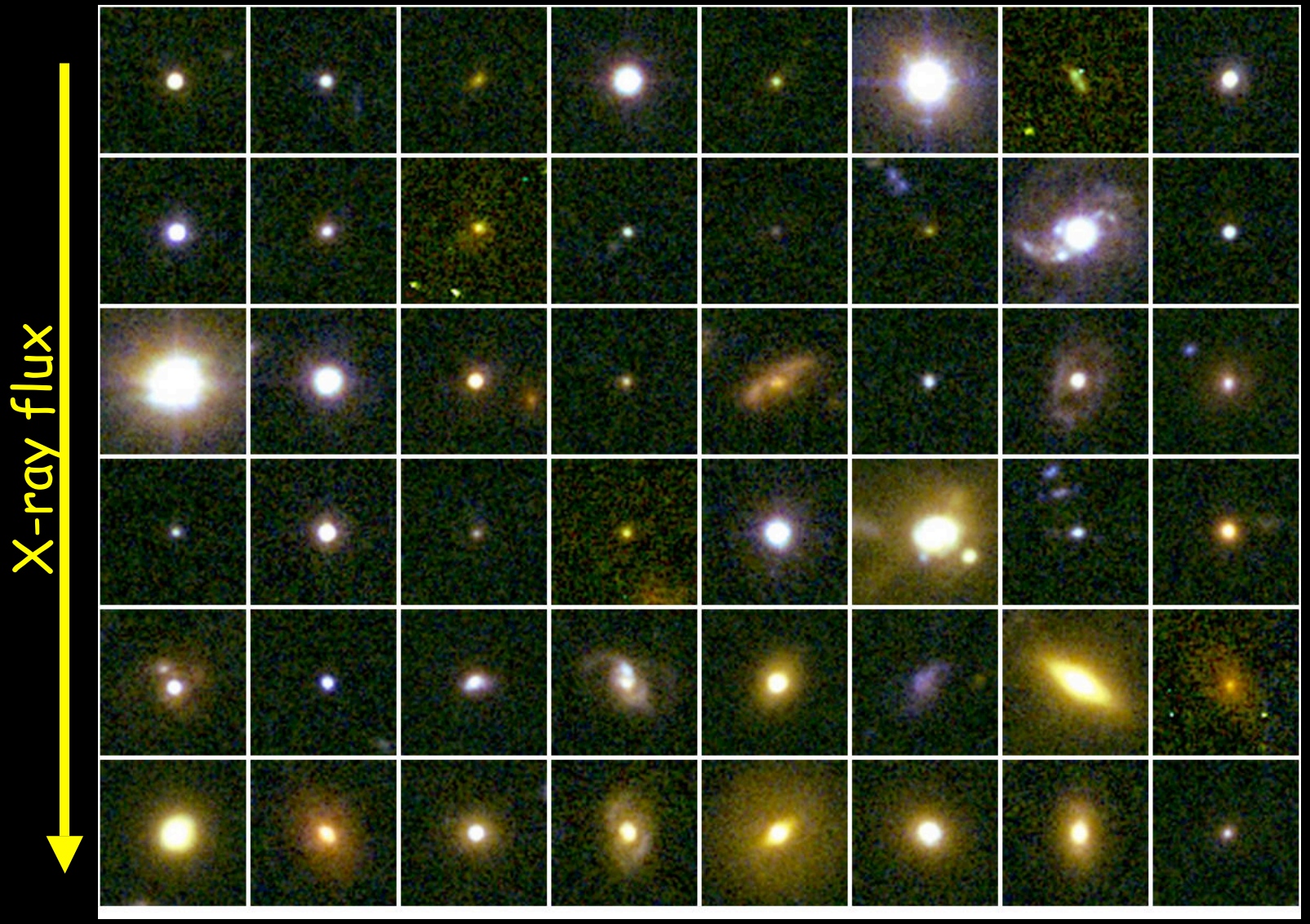
Deep multiwavelength coverage in CDFS



B(10_, 0.2″) = 27.8
V(10_, 0.2″) = 27.8
I(10_, 0.2″) = 27.1
z(10_, 0.2″) = 26.6
J(10_, 0.2″) = 25.5
H(10_, 0.2″) = 24.9
K(10_, 0.2″) = 25.1

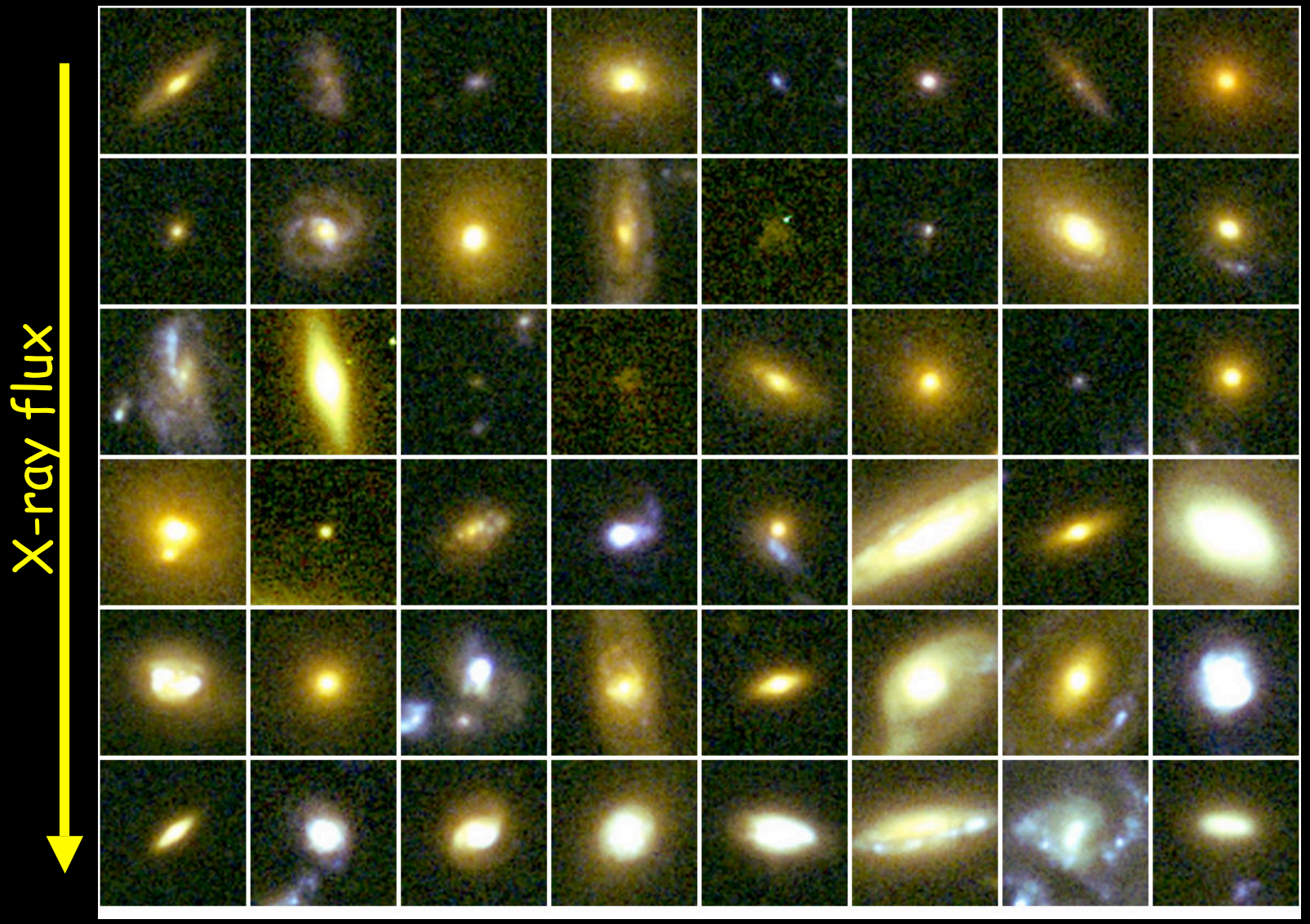
AB mags

AGN zoo (GOODS ACS data)

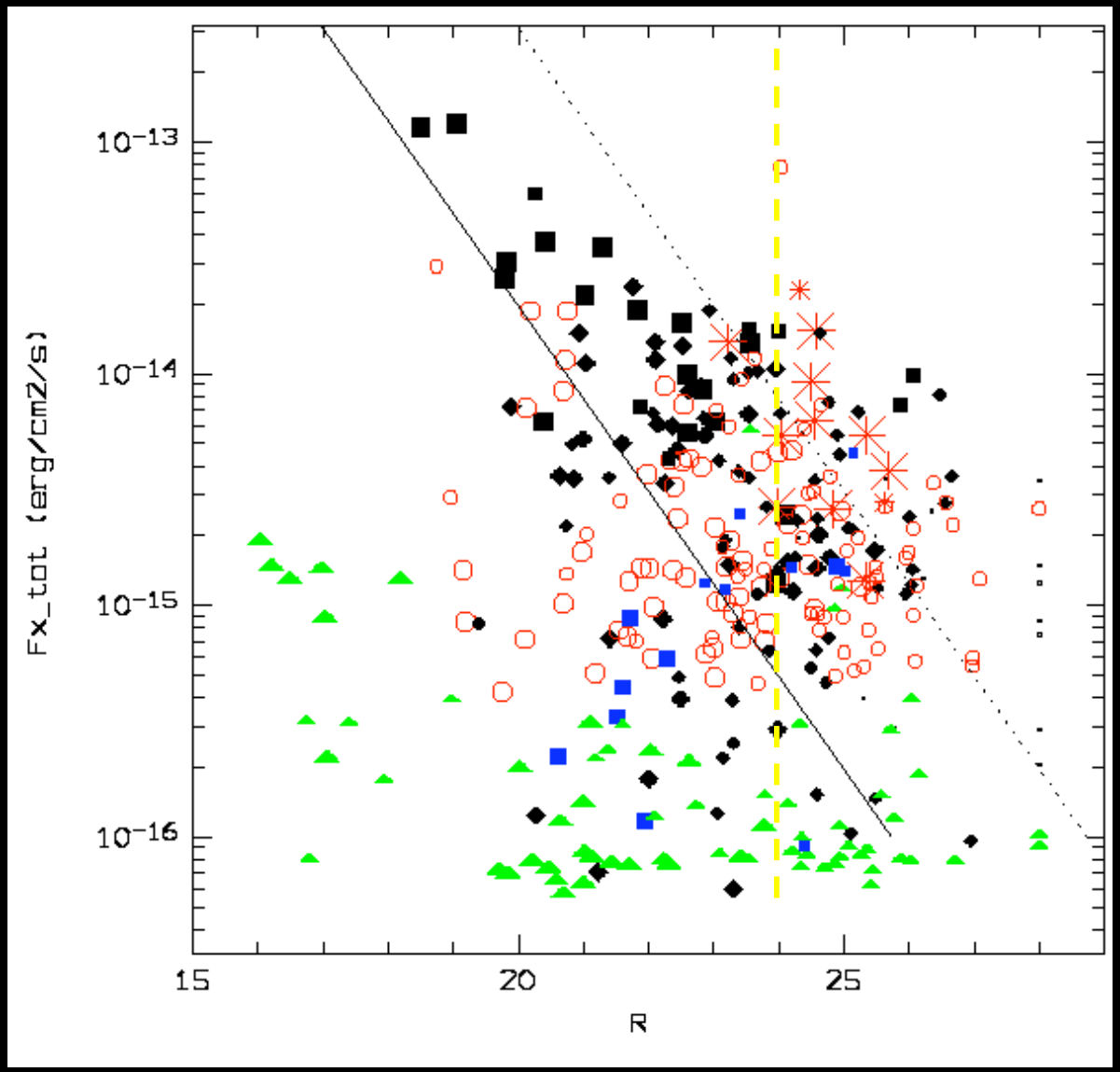


Mainieri 2003, PhD thesis

AGN zoo (GOODS ACS data)

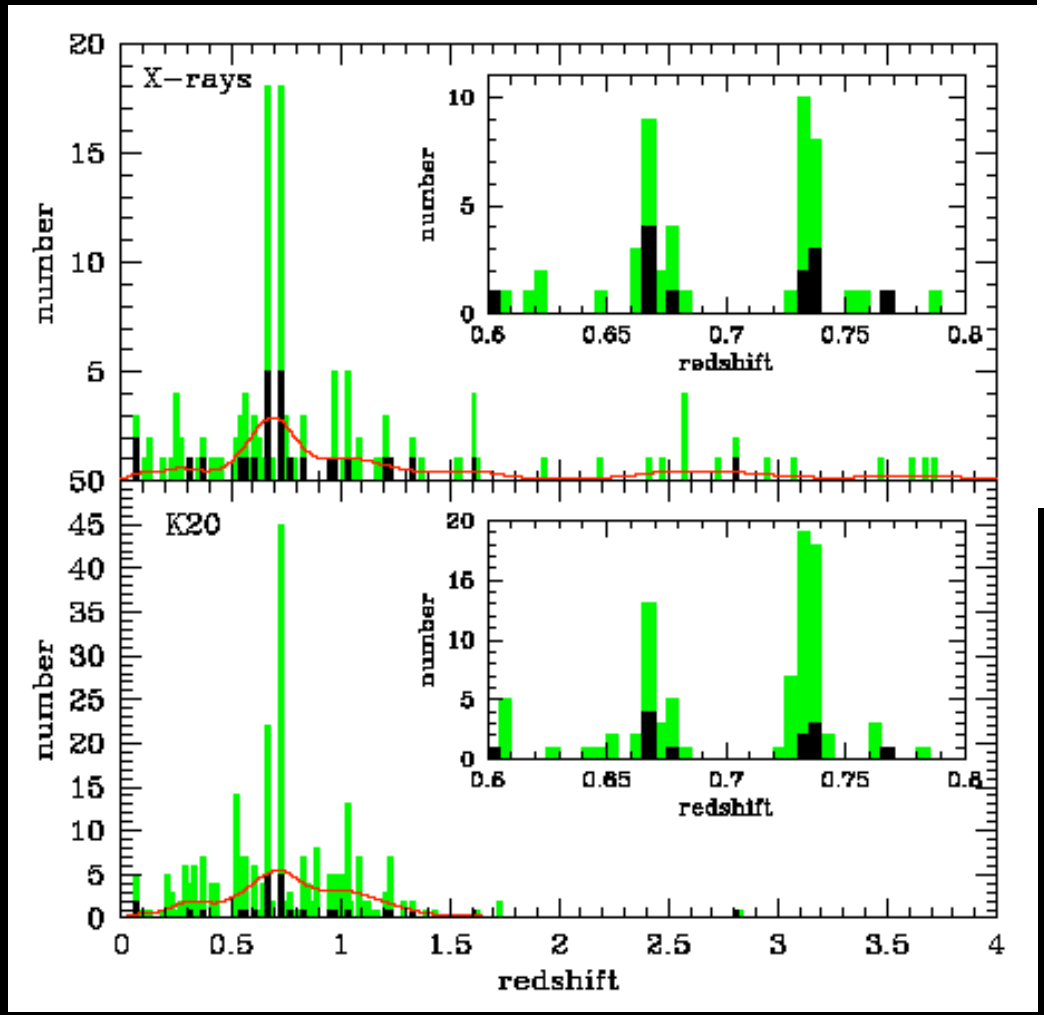


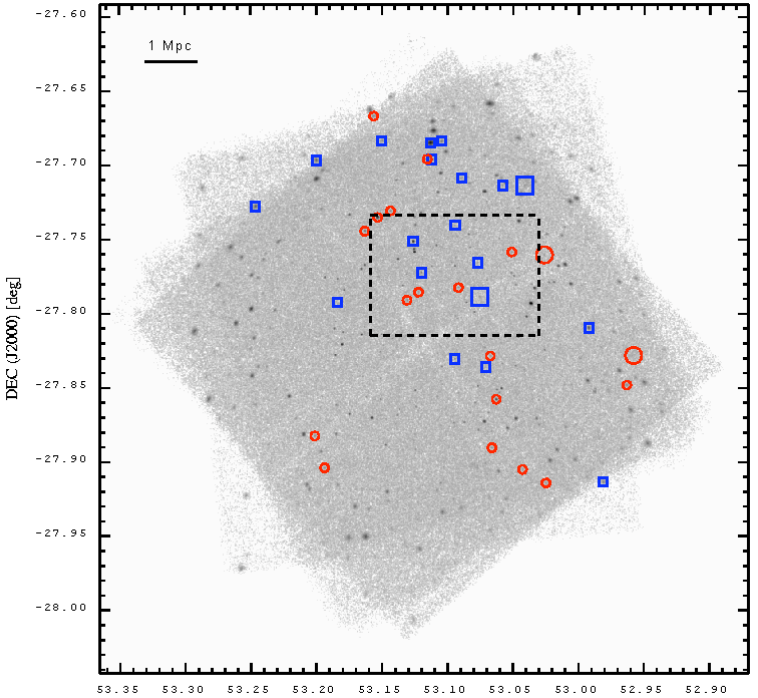
Spectro+Photo IDs

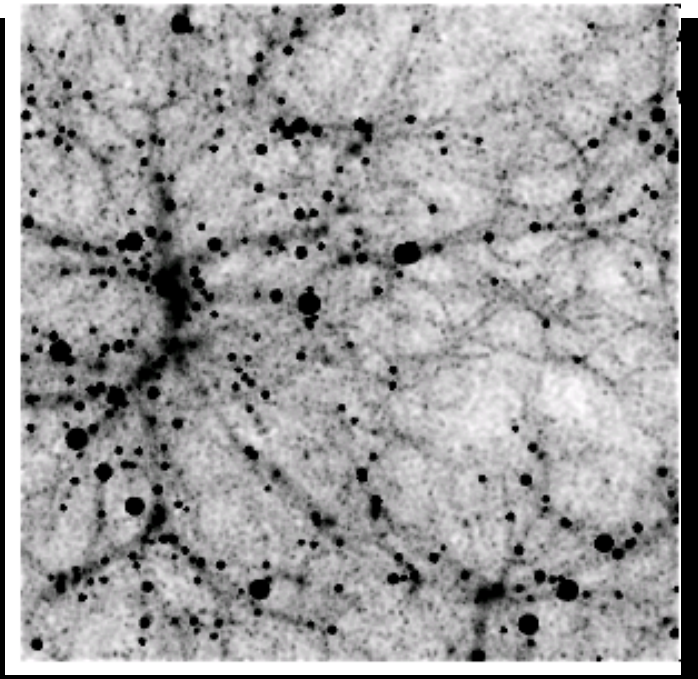


- Larger symbols: spectro-zs
- Smaller symbols: photo-zs
- Incompleteness is only 5% with HST/VLT photo-z!
- See Koekemoer et al. for the optically empty error circles

AGN in Sheets







Gilli et al., 2003, CDF-S results

QSO-2 detected

CDFS #202: type-2 QSO
z=3.705

narrow high-excitation lines

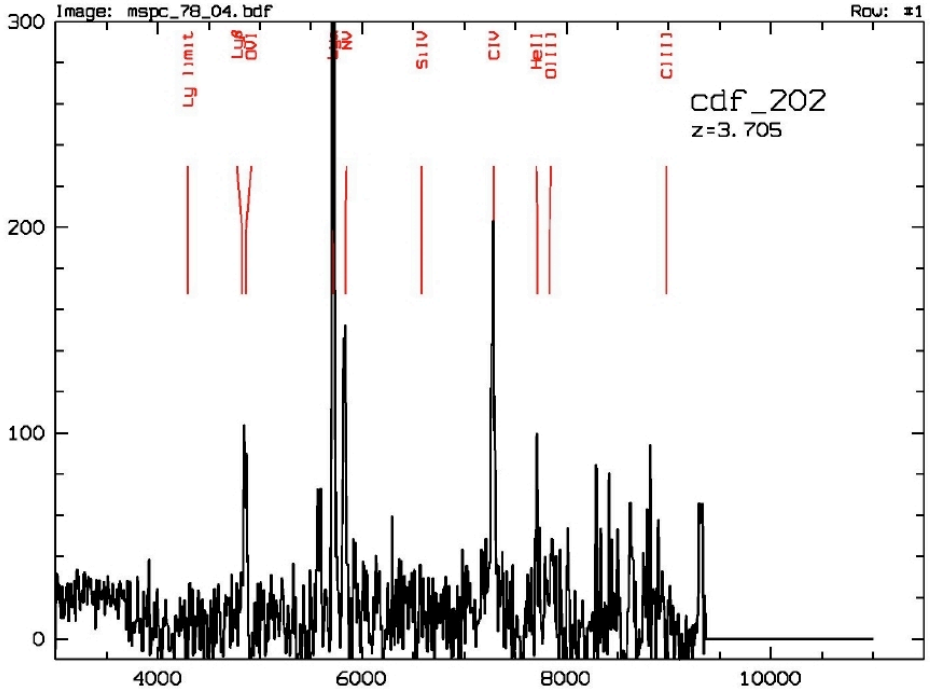
$L_X \sim 10^{45}$ erg/s

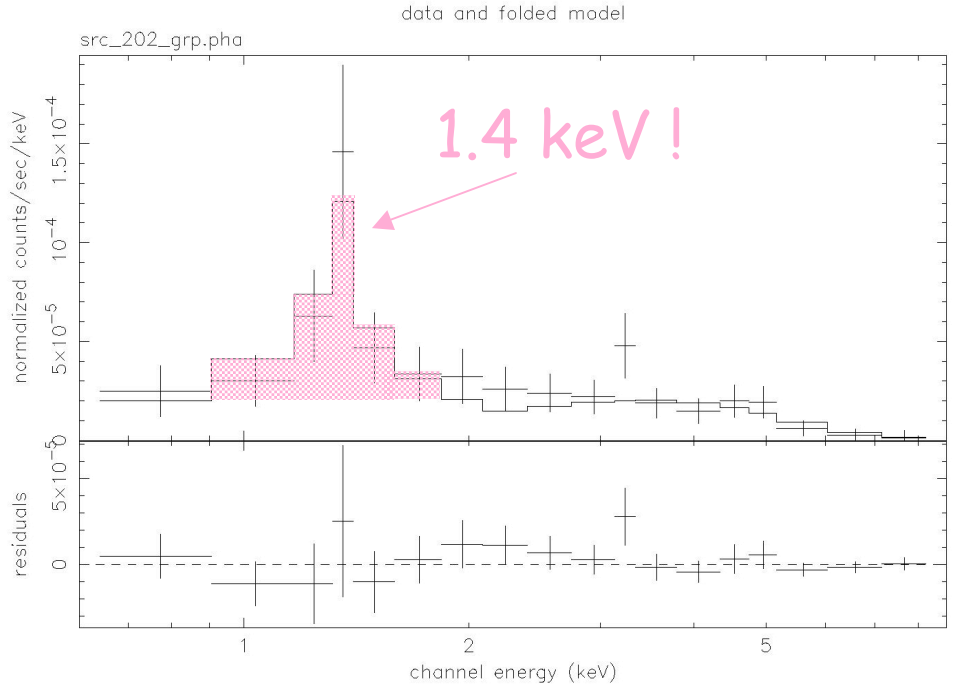
$N_H \sim 10^{24} cm^{-2}$

Fe-line @ 6.4 keV

VLT-spectrum

Chandra spectrum

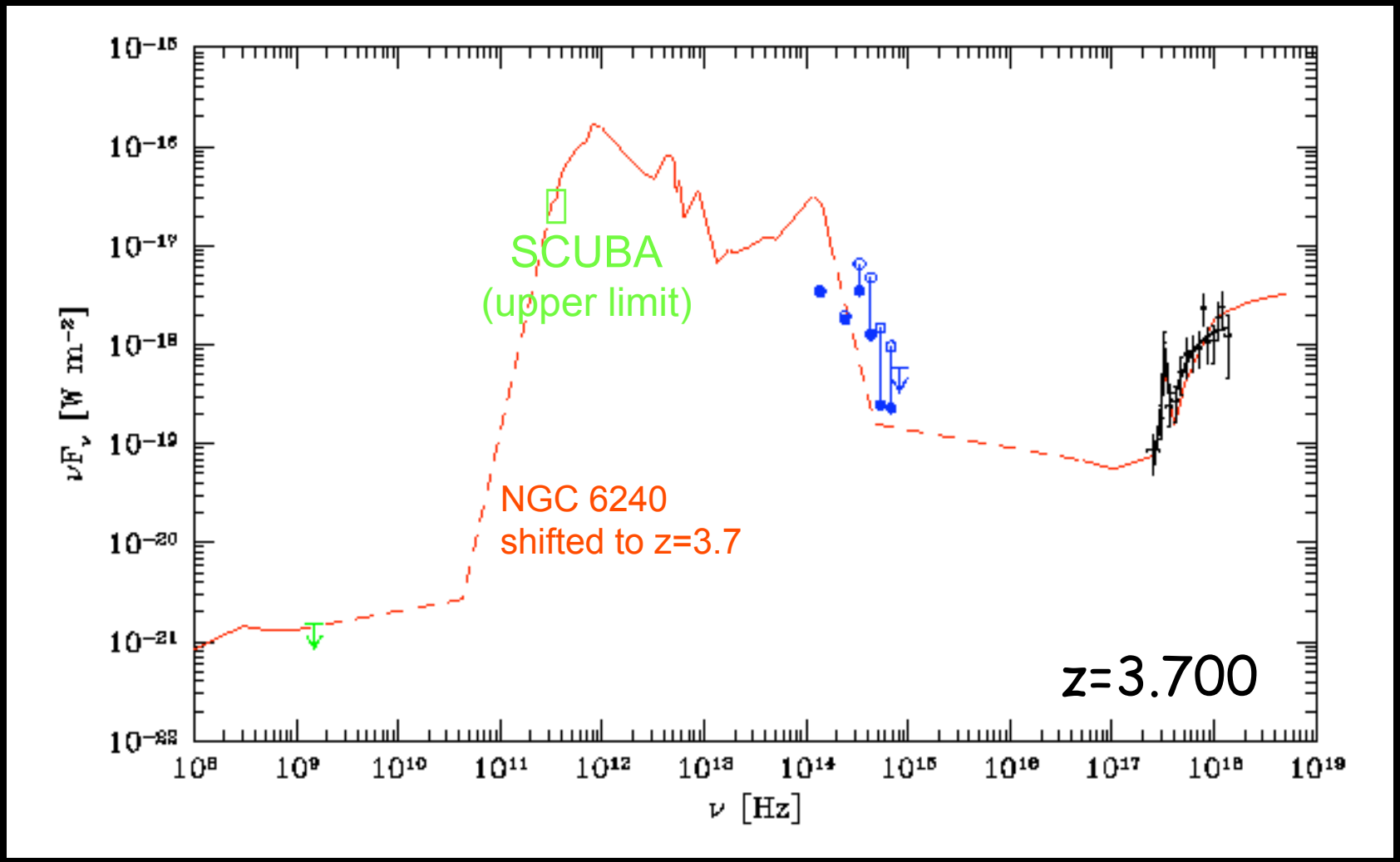




Norman et al., 2001

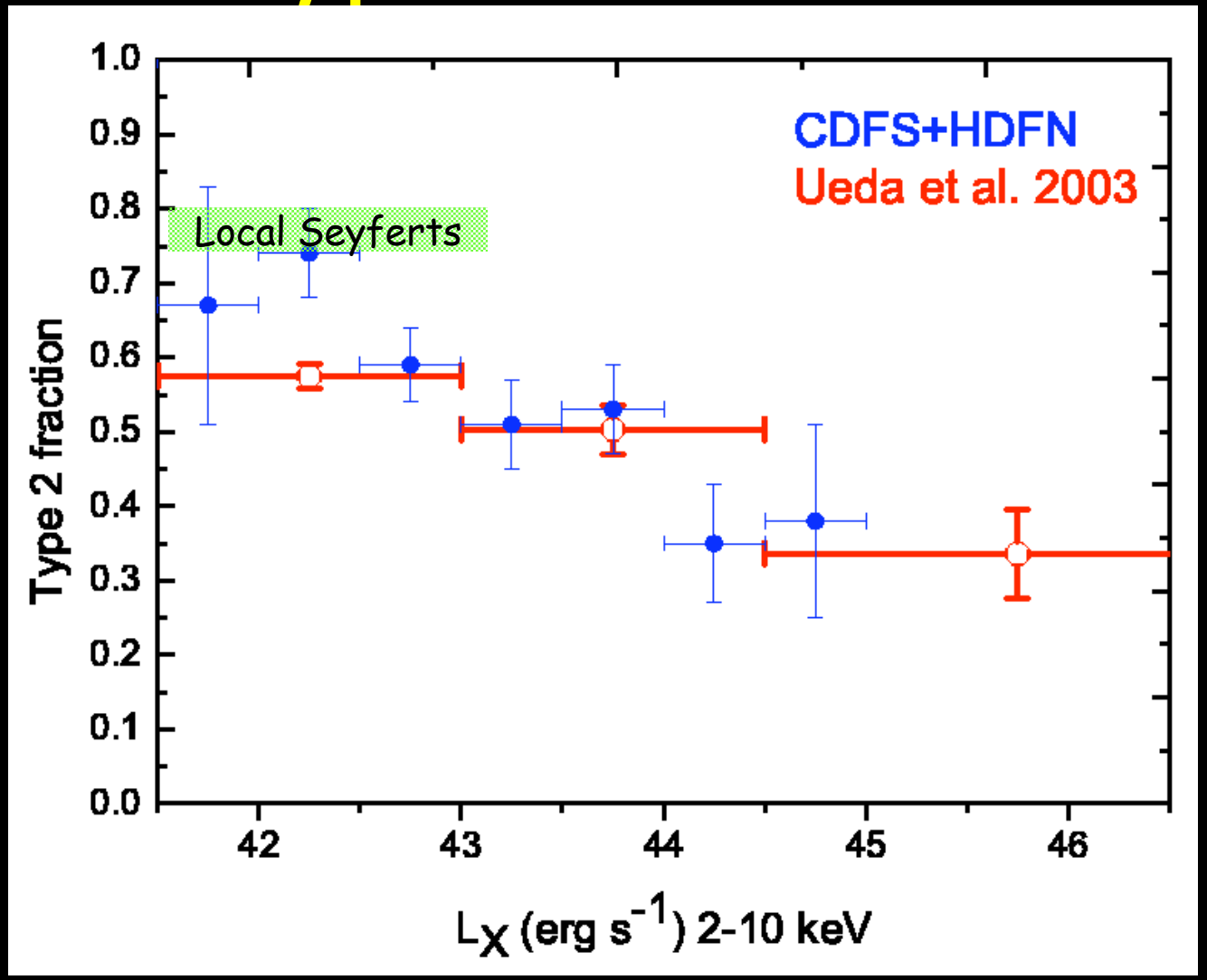
=> Rosetta-Stone for X-ray Background !!!

Prototypical QSO2 CDFS #202



- High-redshift carbon copy of NGC 6240 !

Type 2 fraction



Fraction of type-2's decreses with luminosity

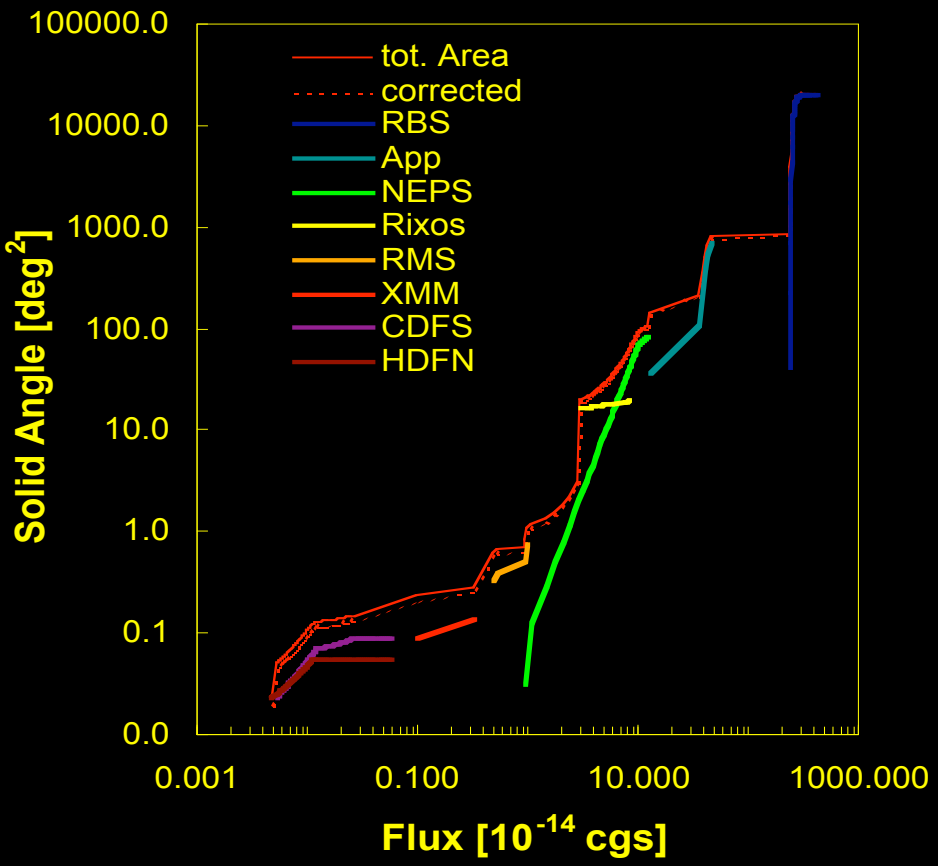
Ueda et al., 2003; Szokoly et al., 2003

Multi-Cone Surveys

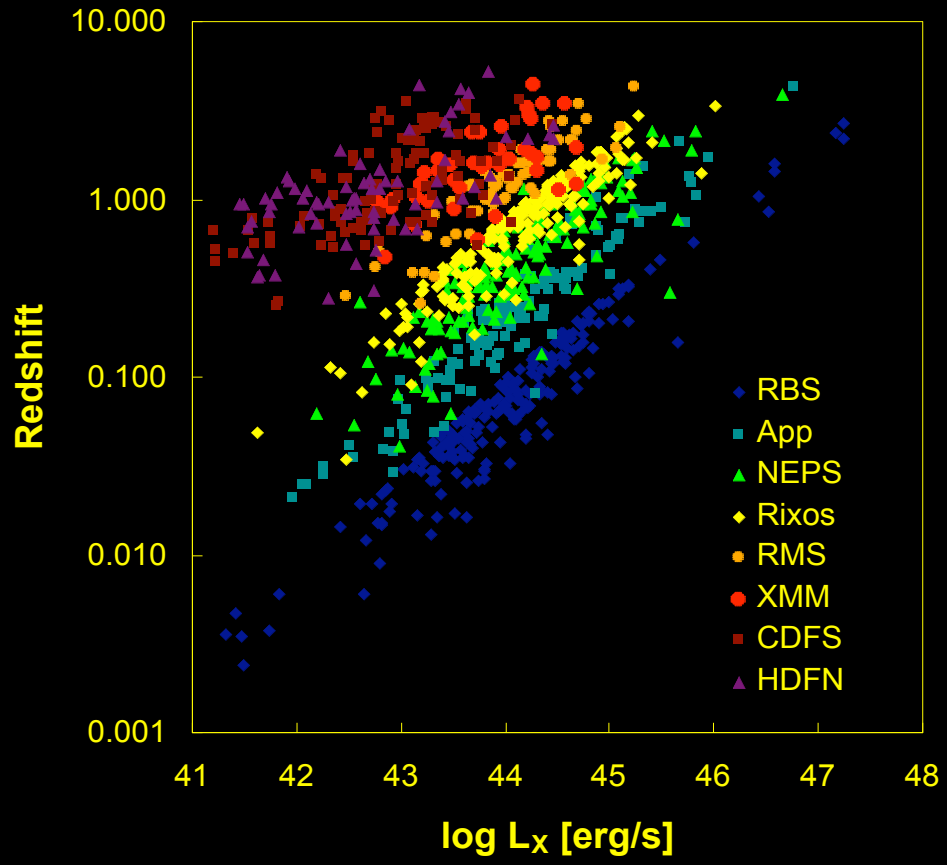
- Type-1 AGN in the 0.5-2 keV band
  - Continuation of ROSAT work, most sensitive & complete
- ROSAT Samples (Miyaji et al., 2000)
  - ROSAT Bright Survey: 217 AGN (Schwope et al., 2000)
  - RASS Selected North: 133 AGN (Appenzeller et al., 1996)
  - RASS NEP Survey: 165 AGN (Gioia et al., 2003)
  - RIXOS serendipitous: 206 AGN (Mason et al., 2000)
  - ROSAT Deep Surveys: 78 AGN (e.g. Schmidt et al., 1998)
- XMM Deep Survey (Hasinger et al., 2001)
  - Lockman Hole: 42 AGN (Lehmann et al., 2001 ++)
- Chandra Deep Surveys
  - CDF North/HDF-N: 73 AGN (Barger et al., 2003)
  - CDFS spec.+phot.: 106 AGN (Szokoly, Zheng et al. 2003)

Multi-Cone Surveys

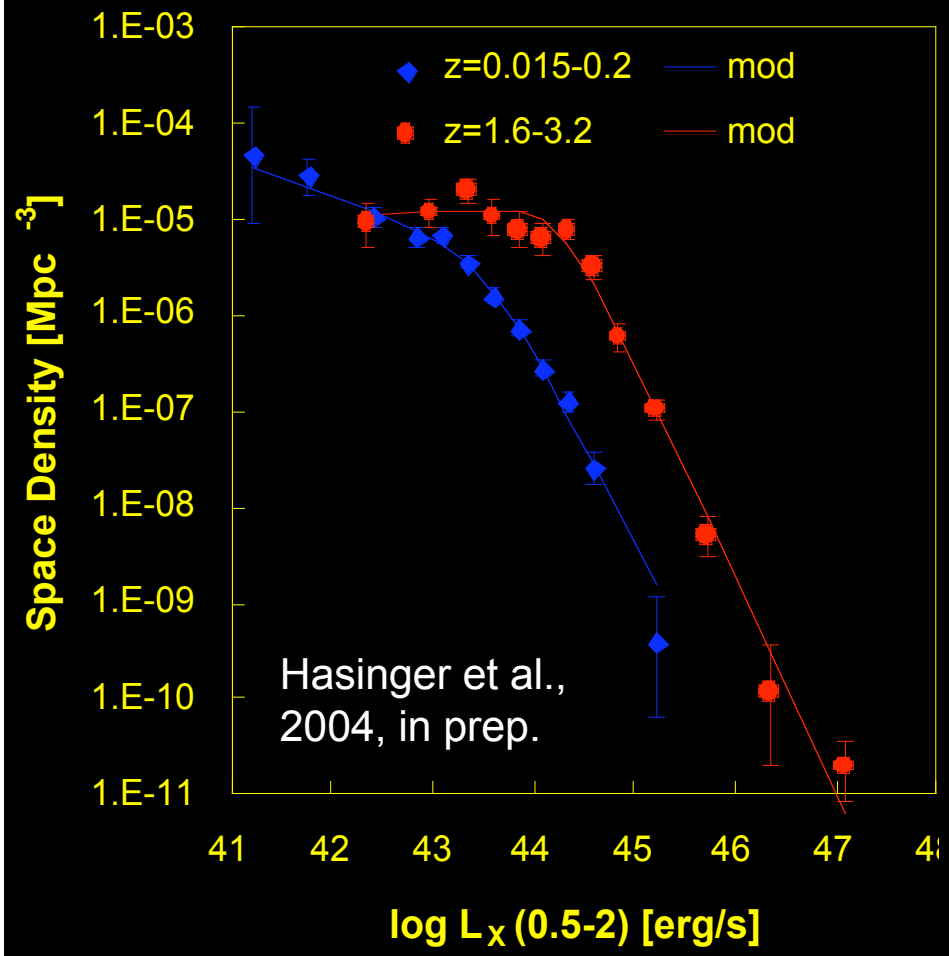
Survey Area

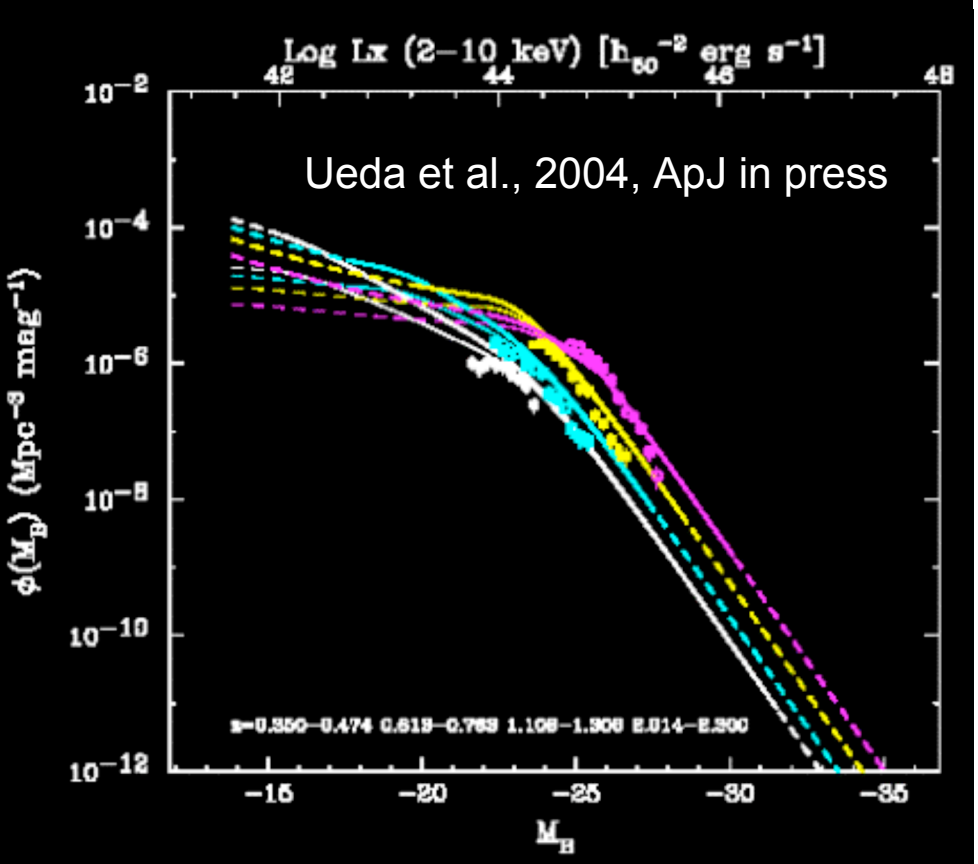


Hubble Diagram



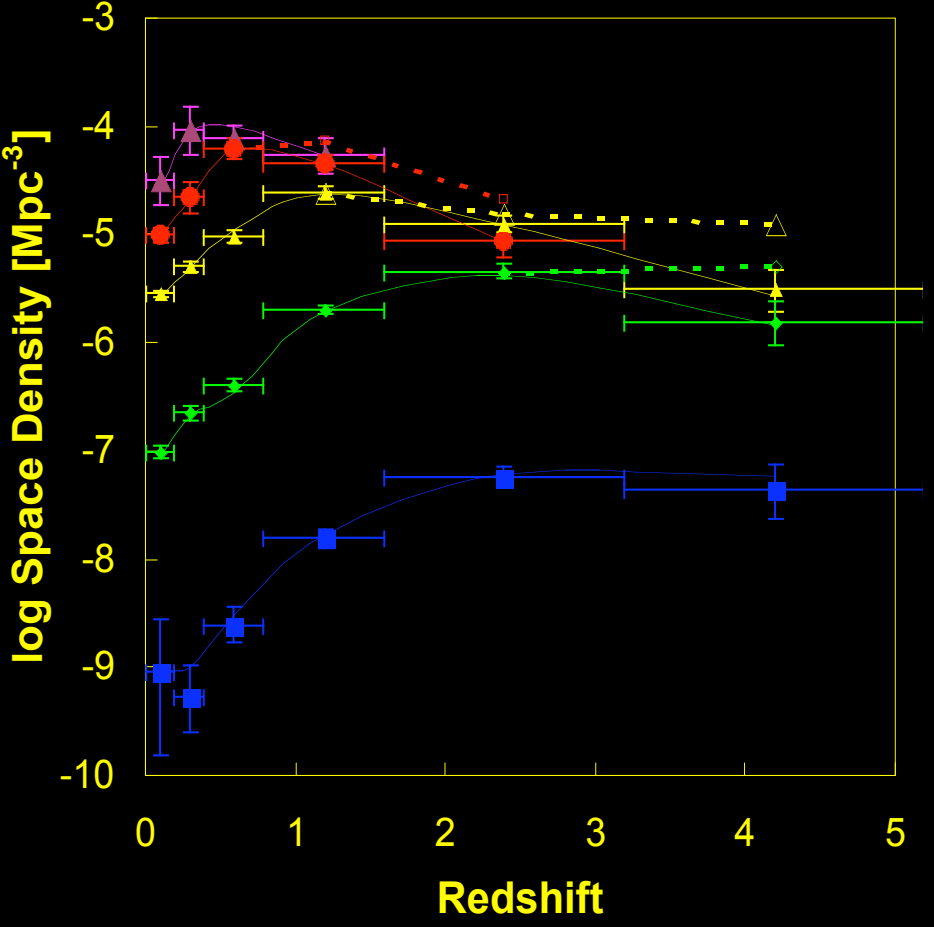
Luminosity Functions X-ray/optical

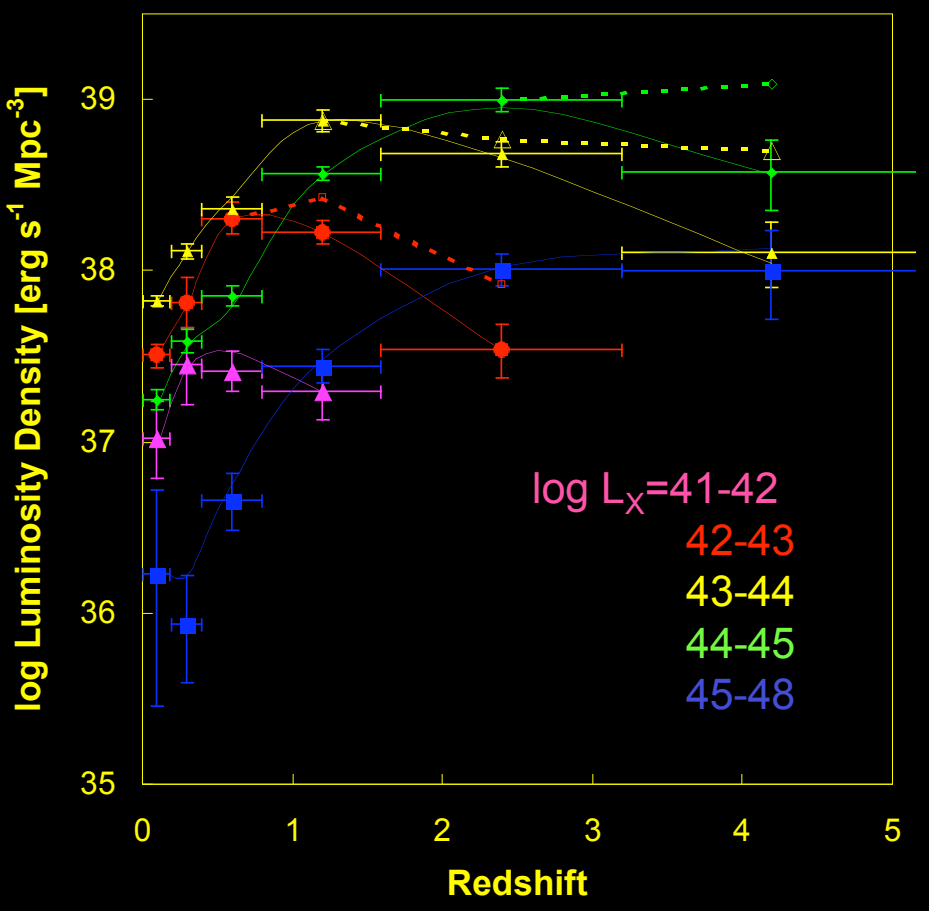




- Change of XLF as a function of redshift
- Luminosity-dependent density evolution

Space/Luminosity Density





Hasinger, Miyaji, Schmidt, 2004, in prep.; see Miyaji poster

Seyferts come significantly later than QSOs !

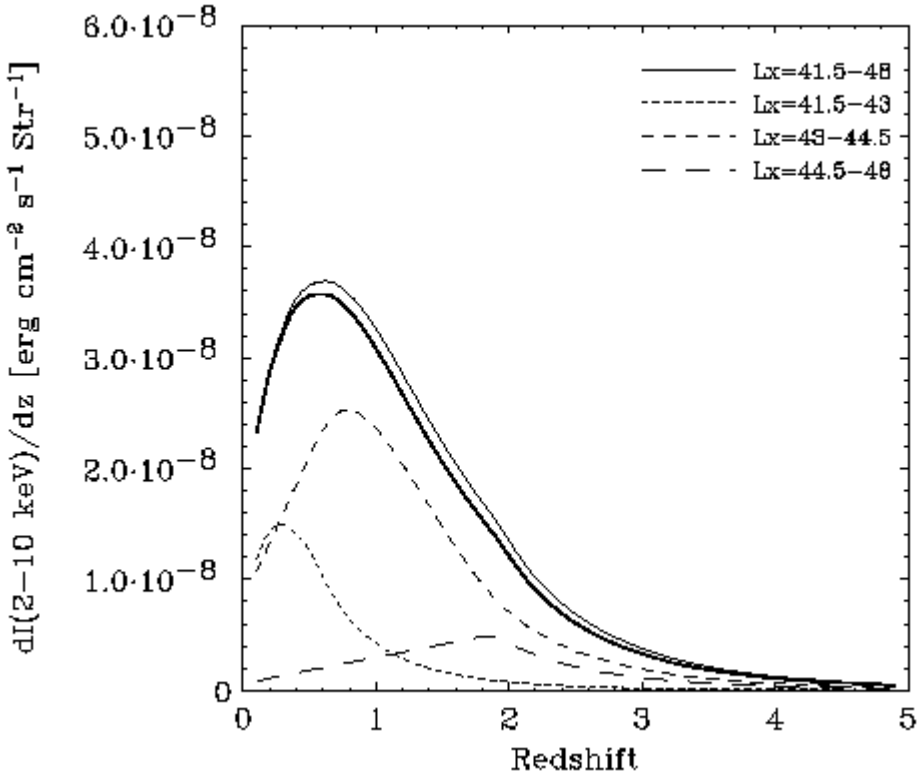
Summary

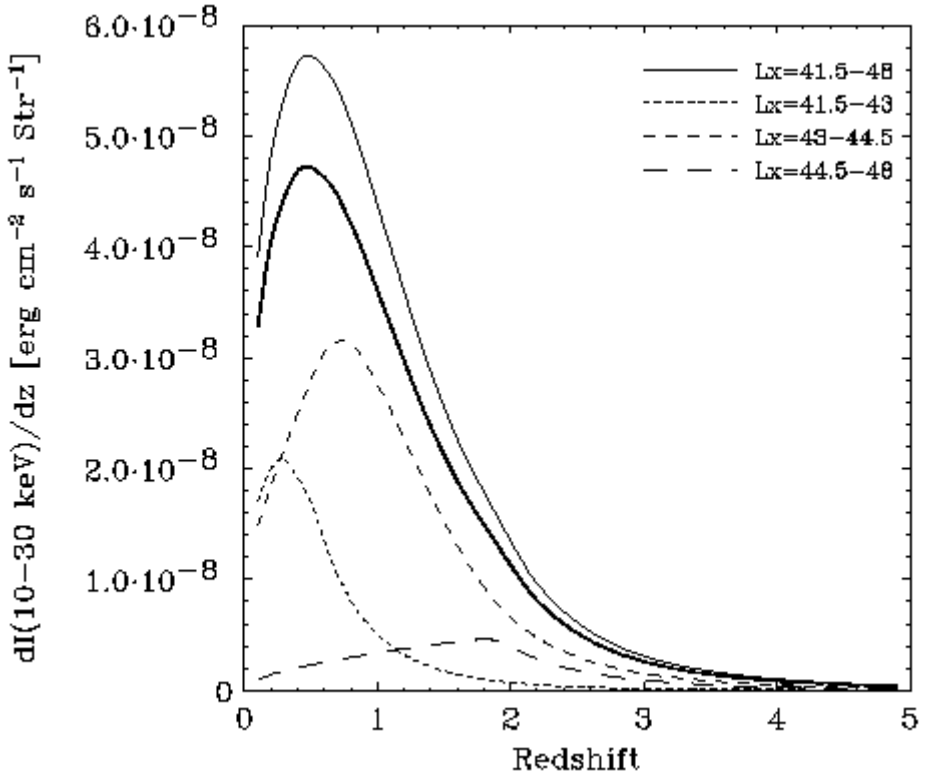
- Majority of AGN not detectable optically (1/10!)
- Type-2 QSOs found, type-2 fraction decreases with L_X
- Seyferts peak much later than QSO and like to live in redshift spikes (sheets)

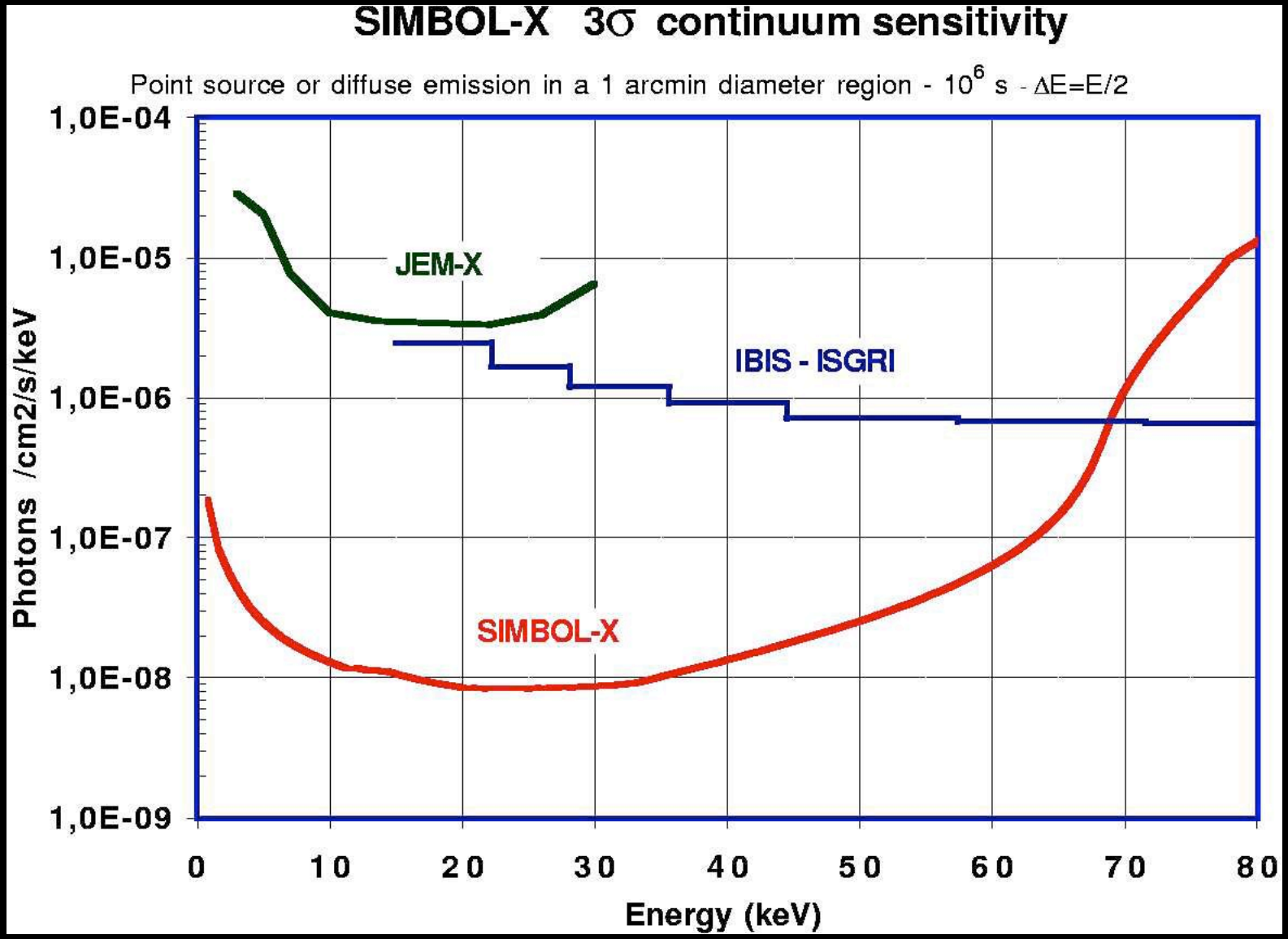
=> Need two modes of BH accretion

- Still large numbers of hard sources to resolve

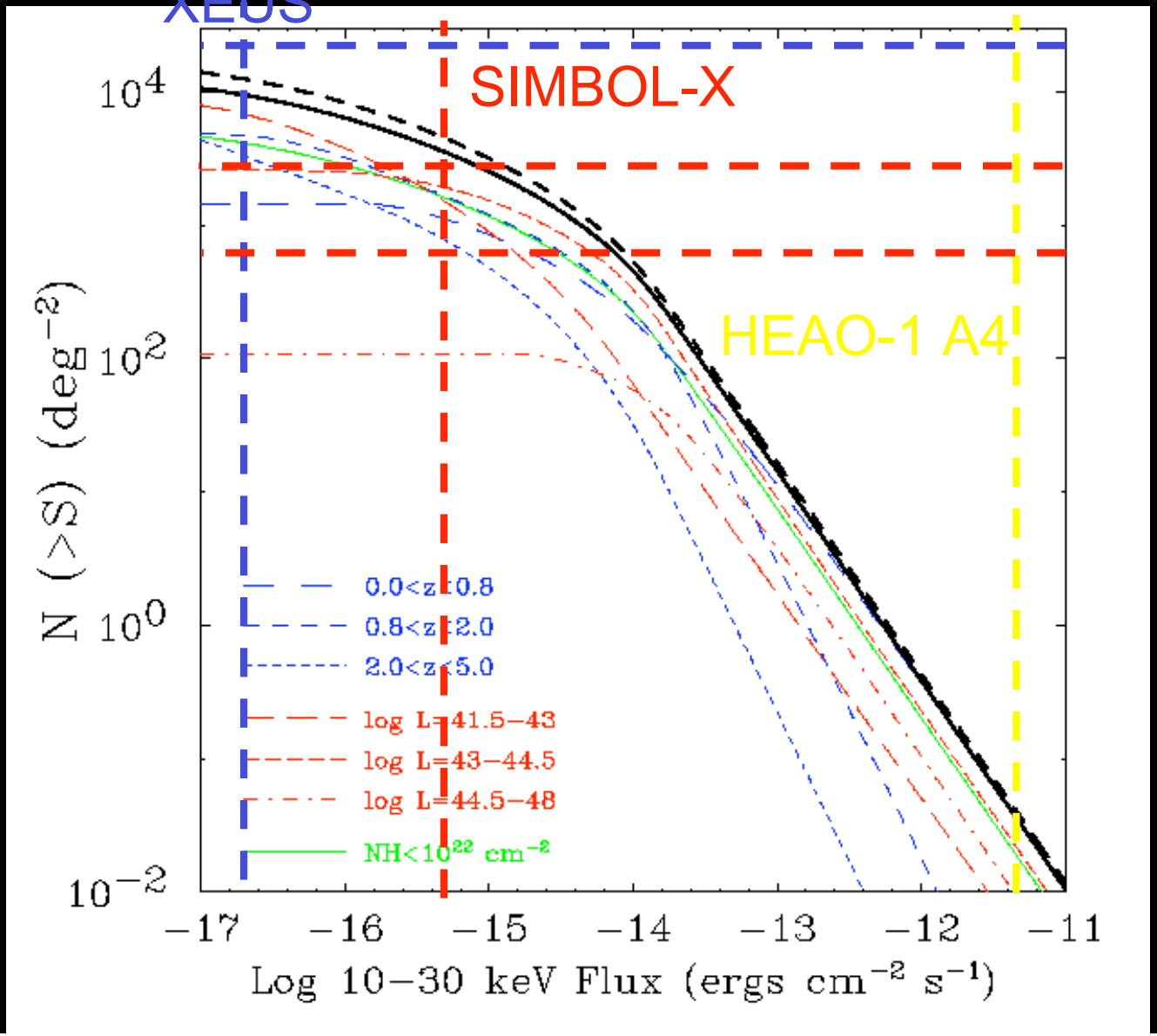
Background Synthesis Models






SIMBOL-X 3σ continuum sensitivity
Point source or diffuse emission in a 1 arcmin diameter region - 10^6 s - ΔE=E/2
1,0E-04
1,0E-05
1,0E-06
1,0E-07
1,0E-08
1,0E-09
Photons /cm2/s/keV
JEM-X
IBIS - ISGRI
SIMBOL-X
0
10
20
30
40
50
60
70
80
Energy (keV)

Number Counts



Confusion Limit

5“ HEW

15“ HEW

30“ HEW

Thank you very much !